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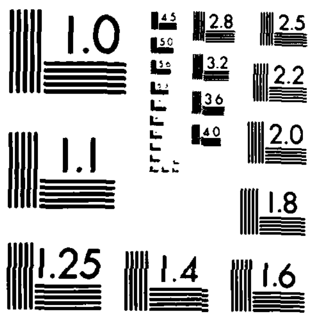
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Currently available emperical models of the low latitude ionosphere are seriously in error, especially during high sunspot activity years. Substantial improvement in models is achieved when theoretically calculated profiles are used. However, the fastest theoretical model is prohibitively time-consuming on even the fastest computer. A unique solution to this problem is to theoretically calculate electron density profiles as a function of latitude and local time and then generate coefficients which reproduce these profiles. The coefficients themselves are then easily stored, quickly retrieved and form the basis for a fast, portable, semi-empirical computer code which will produce realistic, low-latitude F-region electron density profiles.

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A SEMI-EMPIRICAL, LOW-LATITUDE IONOSPHERIC MODEL

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INTRODUCTION

Current empirical models of the low-latitude ionospheric F-region (Llewellyn and Bent, 1973; Chiu, 1975; Rawer, 1981) severely underestimate the daytime plasma density scale-height and total electron content (TEC) when compared with actual observations. As illustrated in Figure 1, the International Reference Ionosphere (IRI) described by Rawer (1981) yields daytime TEC values which are 50% lower than observed TEC values at Manila (dip, 14.5°N) in January, 1982. Some improvement occurs when the Bent topside model is incorporated with the IRI but the predicted values are still lower than observed. Substantial improvement is achieved when theoretically calculated profiles (Anderson, 1973) are used to predict TEC values. The reason is that vertical plasma transport by upward $\overline{E}x\overline{B}$ drift produces both topside and bottomside profiles which are much broader (thicker) than Chapman-like profiles. To illustrate this point, Figure 2 shows a comparison between a theoretically-calculated, noontime electron density profile and the predicted IRI-Bent profile.

To calculate electron density profiles whenever they are needed, however, is prohibitively time-consuming on even the fastest computer. A unique solution to this problem is to theoretically calculate electron density profiles as a function of latitude and local time and then generate coefficients which reproduce these profiles. The coefficients themselves are easily stored, quickly retrieved and form the basis for a fast, portable, semi-empirical computer code which will produce realistic, low-latitude F-region electron density profiles.

DISCUSSION

Using the techniques described by Anderson (1973), electron densities as a function of altitude, latitude and local time are calculated by solving the time-dependent ion (O+) continuity equation numerically. The effects of production by photo-ionization, loss through charge exchange with N_2 and O_2 and transport by diffusion, neutral winds and vertical $\overline{E}x\overline{B}$ drift are included. Because $\overline{E}x\overline{B}$ drifts play such an important role in determining the electron density distribution and have a seasonal and solar cycle dependence, the calculations are carried out for equinox and solstice conditions for both solar cycle maximum and minimum periods. The $\overline{E}x\overline{B}$ drift models are patterned after Jicamarca incoherent scatter radar drift observations as reported by Fejer (1981). Other input parameters include the MSIS neutral atmosphere model (Hedin et al., 1977), loss rates determined by Torr and Torr (1979) and appropriate production rates from Torr et al. (1979). A neutral wind model is derived from a number of sources including Dickinson et al. (1981) and Sipler et al. (1983).

Once electron density profiles are obtained they are normalized to the peak electron density, NMAX(F2) and the coefficients which reproduce the normalized profiles are stored. Appropriate coefficients which generate electron density profiles (200-1000 km) every half-hour local time and every 2° dip latitude between 26°N and 26°S dip latitude are calculated. To regenerate density profiles internally, NMAX(F2) is specified using the CCIR (1978) coefficients.

Being able to quickly generate realistic electron density profiles has a number of applications. Besides providing diurnal TEC values at any specified dip latitude or slant path, this model could be used to specify the ambient ionosphere into which chemical release experiments would be performed. This model would give the initial conditions to be used by any chemical release code to determine airglow intensities, percent plasma reduction, size of the depleted region, etc. In addition, such a model would yield flux-tube integrated Pedersen conductivity and electron content values which are important in determining and predicting low-latitude, instability growth rates. Finally, the program would be capable of supplying airglow intensities both in the vertical and at any slant viewing angle desired. It could thus determine the correlation between TEC values and say, 7774 A airglow intensity which could provide "all sky" TEC values from all-sky 7774 airglow maps.

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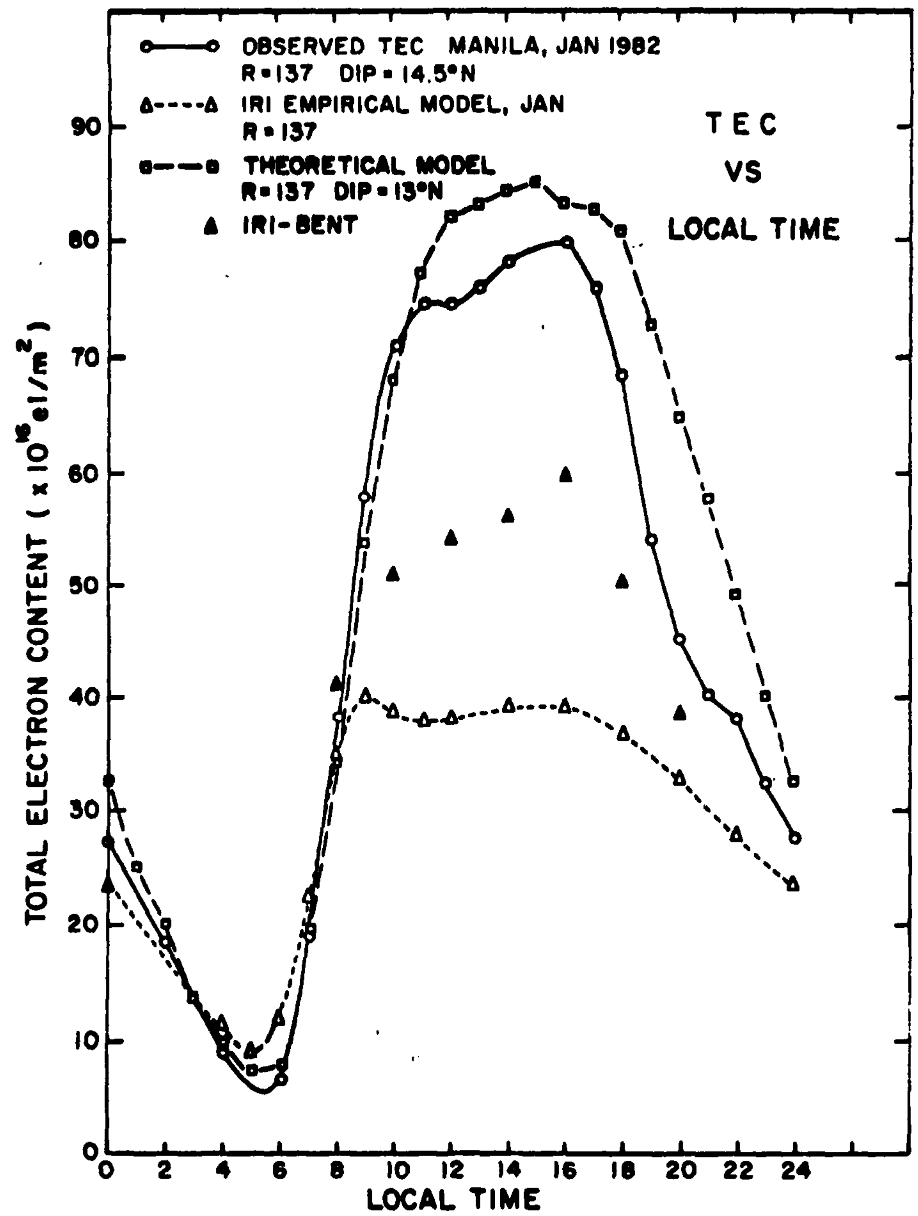
OBSERVED TEC MANILA, JAN 1982
R=137 DIP=14.5°N
IRI EMPIRICAL MODEL, JAN
R=137
THEORETICAL MODEL
R=137 DIP=13°N
IRI-BENT
TEC
VS
LOCAL TIME
TOTAL ELECTRON CONTENT (x 10^16 el/m^2)
LOCAL TIME
0
10
20
30
40
50
60
70
80
90
2
4
6
8
10
12
14
16
18
20
22
24

Fig. 1

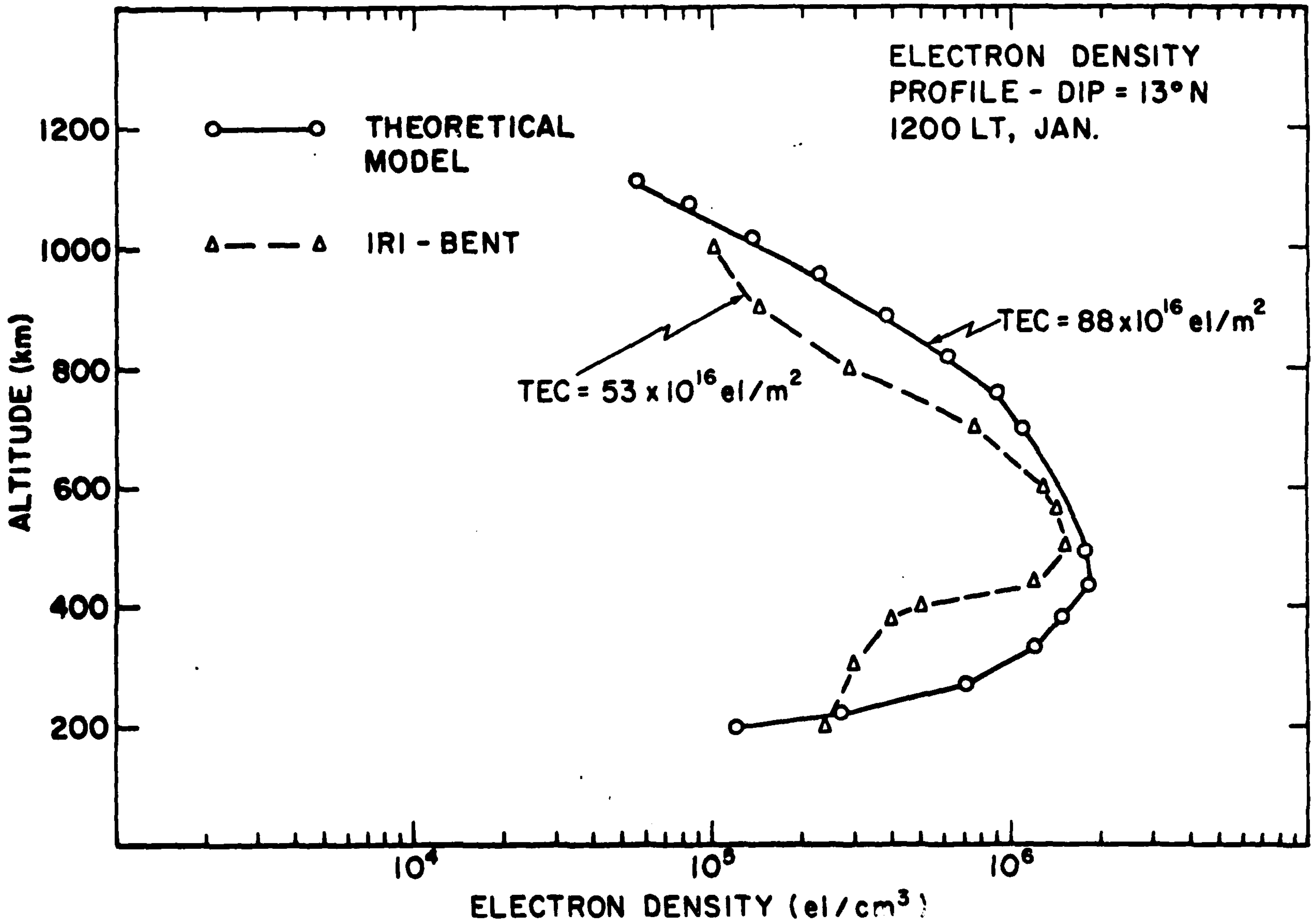
ELECTRON DENSITY
PROFILE - DIP = 13° N
1200 LT, JAN.
THEORETICAL
MODEL
IRI - BENT
TEC = 88 x 10^16 el/m^2
TEC = 53 x 10^16 el/m^2
ALTITUDE (km)
1200
1000
800
600
400
200
10^4
10^5
10^6
ELECTRON DENSITY (el/cm^3)

Fig. 2

D

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